LIFE OPTIMUS

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1 Introduction

1.1 Background and objectives of the deliverable

This deliverable provides a comprehensive description of the baseline conditions of the three pilot cases selected within the LIFE OPTIMUS project, which aims to optimise and implement low-noise asphalt pavements in different traffic and urban contexts and from different points of view.

The report includes detailed information on traffic conditions, transport loads, urban and environmental settings, road surface characteristics, infrastructure typologies, and the level of exposure of residents to road activity.

The main objective is to establish a solid knowledge base to guide the pilot applications in Florence, Forlì, and the Province of Bolzano, facilitating the phases of asphalt optimization and selection, including the integration of Life Cycle Assessment (LCA), Life Cycle Cost (LCC) and (Multi-Criteria Decision Analysis) MCDA criteria.

1.2 Link with LIFE project objectives and activities

This deliverable is directly linked to the technical activities of LIFE OPTIMUS aimed at:

- Identifying and characterizing representative pilot sites with different typologies of traffic and urban environments.
- Collecting and harmonizing data on traffic, transport loads, and residents' exposure.
- Providing baseline conditions necessary to evaluate the impact of innovative low-noise pavements.
- Supporting the decision-making process for the selection and optimization of asphalt mixtures, through both acoustic performance considerations and LCA-LCC-MCDA based sustainability criteria.

The information gathered here serves as the starting point for implementing and monitoring activities, comparative analyses, and the evaluation of the effectiveness of the proposed solutions.

1.3 Methodological approach

The report has been structured around three case studies, each representing a different road and traffic context:

- Florence (urban context): high-density traffic, significant share of light vehicles, and direct exposure of residents.
- Forlì (suburban/medium-size city context): mixed traffic conditions with moderate heavy vehicle loads and peri-urban exposure patterns.
- Bolzano Province (mountain/extra-urban context): challenging infrastructure conditions, seasonal traffic variations, and sensitive environmental settings.

For each case study, the following categories of information have been collected and reported:

- General description of the pilot site and its infrastructural characteristics.

- Traffic and transport load data (including traffic counts, speed profiles, and heavy vehicle percentages).
- Existing road surface conditions.
- Environmental and social context, with particular focus on residents' exposure to noise and other impacts.
- Maps, GIS layers, and photographic documentation where available.

This structured approach guarantees that the three pilot sites can be directly compared and analyzed, thus enabling the LIFE OPTIMUS consortium to identify optimal conditions for the deployment of low-noise asphalt solutions and to assess their potential replicability in other European contexts.

2 Overview of the Pilot Cases

2.1 Selection criteria for pilot sites

The pilot sites selected in LIFE OPTIMUS represent a variety of traffic, infrastructural, and environmental contexts that are particularly suitable to demonstrate the effectiveness and replicability of optimized low-noise asphalt pavements. The criteria guiding the selection included:

- Diversity of traffic typologies, ranging from urban commuting flows to heavy goods transport.
- Different urban and territorial settings, including dense urban neighborhoods, suburban roads, and extra-urban/mountain areas.
- High relevance of residents' exposure to road traffic, either due to population density or proximity of dwellings.
- Representative infrastructure conditions for central and northern Italy, ensuring replicability in other European contexts.

The three pilot areas – Florence, Forlì, and the Province of Bolzano – allow LIFE OPTIMUS to test solutions in complementary contexts and thus build a robust comparative framework.

2.2 Description of the three contexts (urban, suburban, mountain/extra-urban)

The three pilot sites selected within LIFE OPTIMUS cover a wide spectrum of road contexts in terms of traffic intensity, vehicle mix, urban exposure, and speed regimes:

- Florence – Via del Gelsomino (urban context):
    - Speed limit: 50 km/h.
    - Key features: Dense urban fabric with strong direct exposure of residents to road noise. High traffic volumes with predominance of light vehicles and significant bus transit. Noise emissions are strongly influenced by stop-and-go traffic and frequent accelerations/decelerations.

- Relevance: Representative of urban noise scenarios at low speeds, where road surface characteristics are critical in reducing rolling and interaction noise in constrained settings.

- Forlì – Via Ravegnana (suburban context):
  - Speed limit: 50 km/h.
  - Key features: Peri-urban road linking the city to Ravenna, with mixed residential, commericial and industrial surroundings. Vehicle fleet includes a significant share of heavy vehicles due to the road's logistics function.
  - Relevance: Illustrates low-speed suburban conditions, where noise generation derives both from rolling noise and partial aerodynamic effects, combined with exposure of roadside dwellings.
- Bolzano Province – SS 38 (Marlengo) and SS 12 (Laghetti/Egna) (extra-urban/mountain context):
  - Speed regime: Highway-like (110 km/h SS38 and 50 km/h SS12).
  - Key features: High traffic corridors with strong presence of heavy goods vehicles, seasonal traffic fluctuations (tourism), and direct exposure of settlements located along or adjacent to the road.
  - Relevance: Representative of medium-high speed extra-urban and mountain scenarios, where rolling noise dominates and the performance of low-noise asphalts is maximized, but durability and climatic resistance are equally critical.

This differentiated approach guarantees that LIFE OPTIMUS assesses the effectiveness of optimized low-noise asphalt surfaces across the full range of real traffic conditions most relevant for European roads.

Pilot Site	Length	Speed	Traffic Mix	Residents' Exposure
Florence – Via del Gelsomino	~800 m	50 km/h	Light vehicles + buses	Dense urban fabric, schools, commercial activities
Forlì – Via Ravegnana	~400 m	50 km/h	Mixed traffic, including heavy vehicles	Peri-urban context with residential, industrial and commercial buildings
Bolzano – SS 38 Marlengo	~2.6 km	110 km/h	High traffic intensity, commuters + trucks	Settlement of Marlengo adjacent to the road
Bolzano – SS 12 Laghetti/Egna	~2.6 km (focus ~500 m)	50 km/h	International transit, high share of heavy goods vehicles	Settlement of Laghetti (1,400 inhabitants) directly crossed by the road

2.3 Expected contribution to project goals

The three pilot sites selected within LIFE OPTIMUS – Florence, Forlì, and the Province of Bolzano – will contribute significantly to achieving the project objectives by providing representative testbeds that reflect the diversity of road traffic and urban contexts across Europe. Their contribution can be summarized as follows:

- Validation of optimized asphalt mixtures under real conditions

  The pilots will serve as full-scale demonstrators where the asphalt mixtures optimized through laboratory tests, Life Cycle Assessment (LCA), and acoustic performance analysis will be implemented and monitored. This will allow LIFE OPTIMUS to verify the expected reduction in noise emissions and to assess the durability and sustainability of the solutions.

- Coverage of different speed regimes and road typologies

  The selected sites cover the most relevant traffic conditions influencing noise emissions:

  - Low/medium-speed urban and suburban context (Florence, 50 km/h - Forlì, 50 km/h).
  - Medium/High-speed extra-urban/mountain context (Bolzano, 50–110 km/h).

    This variability guarantees that the project can generate knowledge applicable to a wide spectrum of European road infrastructures.

- Assessment of residents' exposure and social benefits

  Each pilot site presents direct exposure of residents to road activity, from densely populated areas in Florence to small settlements along Alpine corridors. The pilots will thus allow quantification of the social benefits of noise reduction, supporting both local stakeholders and broader EU policy objectives.

- Contribution to policy and replicability

  By addressing urban, suburban, and extra-urban contexts, the pilots will provide a robust evidence base for policymakers and road authorities to evaluate the transferability of optimized low-noise asphalts to other European contexts.

In summary, the LIFE OPTIMUS pilot cases are expected to:

1. Demonstrate the technical and environmental effectiveness of optimized low-noise asphalt mixtures.
2. Quantify the benefits for citizens in terms of noise exposure reduction and improved quality of life.
3. Validate the applicability of the solutions in different traffic and environmental conditions, thereby enhancing replicability and scalability at EU level.

3 Pilot Case 1 – Florence (Urban context)

3.1 General description of the site (geographical, urban and infrastructural context)

Via del Gelsomino is located in the southern sector of the city of Florence (Italy) in the administrative district of Galluzzo–Due Strade (Quartiere 3). The site lies approximately 2.5 km south of the historical city centre, in a semi-urban area that combines residential, institutional, and green functions within a moderately trafficked road network.

From a geographical and morphological standpoint, the area occupies the first hillsides overlooking the Arno River plain, with gentle gradients and predominantly asphalted surfaces. The surrounding urban fabric consists mainly of residential buildings, small commercial premises, and public facilities, interspersed with landscaped zones and tree-lined sidewalks. The nearby Giardino del Gelsomino, a 5,000 m² public garden opened in recent years, helps to the environmental and social value of the area, offering a buffer space for noise and air-quality monitoring.

Via del Gelsomino functions as a local collector road connecting the Galluzzo–Due Strade district with major arteries such as Via Senese, which provides direct access to the Florence–Siena regional corridor and the city's inner ring road. Although not classified as a primary urban route, the street supports steady vehicular circulation throughout the day, including private cars, public service vehicles, and access traffic to nearby residential complexes and parking facilities. A park-and-ride area located at Via del Gelsomino 11 further increases local traffic volumes during commuting hours.

Public transport connectivity is ensured by several bus lines serving the adjacent Via Senese and Via dei Grecchi corridors, linking the neighbourhood with the central station Santa Maria Novella and other strategic points of the city. The road infrastructure includes on-street parking bays, pedestrian crossings, and limited-width sidewalks typical of suburban Florence. Local topography and the proximity of green areas make the site suitable for acoustic and environmental monitoring, including assessments of traffic noise propagation and particulate dispersion.


Via Benedetto Castelli
Via Benedetto Ca
V.le Lorenzo Magalotti
Via del Gelsomino
Viale dei Poggi
Società San Paolo
Scuola statale Acciaiuoli - Istituto
Via Senese
Studio Stroder
SCAF - Area Sosta Camper...
Via Leonardo Ximenes
Il Paracadute di Icaro
Argentiere b&b Firenze
Via Alfonso Borelli
VILLA GELSOMINO GARDEN
Giardino di via del Gelsomino
del Gelsomino
Via Grecchi
Chianti Infissi
Via Senese
Asili Nido Comunale CUCU
Via Leonardo Ximenes
Fiorenza Bed and Breakfast

Figure 1: Firenze–Via del Ponte alle Mosse project section

3.2 Road and infrastructure characteristics (geometry, surface, age, maintenance)

Via del Gelsomino is a local two-lane urban road approximately 450 metres long and 6–7 metres wide, with a mild longitudinal slope (2–3%) and limited curvature. The road alignment follows the historical layout established in the late 19th century, when the area was first urbanised as part of the southern suburban expansion of Florence. The cross-section includes a bituminous asphalt surface, granite or concrete curbstones, and narrow sidewalks on both sides (1.0–1.2 m). Drainage is managed through surface channels connected to the municipal stormwater system via gully pots and inspection manholes.

The pavement structure consists of a dense-graded asphalt wearing course over a bituminous binder layer and granular base, typical of municipal streets of medium traffic intensity. The last major resurfacing and maintenance works were carried out between 2020 and 2022, involving full-depth patching, manhole adjustment, and the application of a new asphalt layer. As a result, the pavement is in good structural and functional condition, providing a consistent baseline for comparative testing of new low-noise and high-durability surface materials.

Ancillary infrastructure includes public lighting (LED fixtures), horizontal and vertical signage, and sidewalk curbs recently restored in selected sections. The overall infrastructure configuration reflects a typical suburban collector road with moderate vehicular flow, residential access, and limited heavy-vehicle traffic.

3.3 Age and historical background

Via del Gelsomino dates back to the late 19th century, when the southern hills of Florence began to be progressively urbanised beyond the historic walls. Originally designed as a residential access road connecting the suburban villas and institutional properties located along Via Senese, it has gradually evolved into a local collector serving the Galluzzo–Due Strade neighbourhood. The surrounding area underwent significant transformation during the mid-20th century, with the construction of multi-unit residential buildings and public facilities, while maintaining the original road alignment and relatively narrow cross-section typical of early suburban developments in Florence. Although not part of the historical centre, the street retains architectural and landscape features consistent with the traditional Florentine hillside context, including stone retaining walls and mature vegetation along its borders.

3.4 Geometry and cross-section

Via del Gelsomino extends for approximately 800 metres between Via Senese and Via dei Grecchi, following a gentle longitudinal gradient of about 2–3 %. The carriageway width varies between 6.0 and 7.0 metres, accommodating two-way traffic with alternating on-street parking bays on one side. The cross-section typically includes asphalt pavement, narrow sidewalks (1.0–1.2 m) on both sides, and curbstones in granite or concrete. Surface drainage is ensured through side channels connected to storm-water inlets located near inspection manholes. The geometric layout is mostly rectilinear, with a slight curvature near the junction with Via dei Grecchi and limited visibility at intersections due to vegetation and property walls. The topographical configuration and modest slope make it suitable for the installation of experimental pavement sections and measurement equipment.

3.5 Signage and safety elements

Vertical and horizontal signage complies with standard municipal conventions. Road markings include central separation lines, stop lines at intersections, and pedestrian crossings near the main access points. Regulatory and warning signs are mounted on both sides of the carriageway, though some show moderate wear or partial obstruction by vegetation. Speed regulation is set at 30 km/h within the residential zone, with occasional "traffic-calming" signage and limited physical measures such as raised crossings or speed humps. Public lighting is provided by pole-mounted LED fixtures, recently upgraded during maintenance operations. Safety elements also include guardrails and bollards at sensitive points near pedestrian accesses and the adjacent public garden.

3.6 Overall condition

The general condition of Via del Gelsomino is good, following resurfacing and manhole-replacement works completed between 2020 and 2022 by the Municipality of Florence. The pavement exhibits a uniform surface texture with limited evidence of distress such as minor longitudinal cracking and superficial ravelling in localized spots. Drainage performance is adequate, though some curb segments show partial deformation and vegetation encroachment. Signage and lighting systems are functional, while sidewalks remain narrow and partly uneven, reflecting the street's historical layout.

4 Pilot Case 2 – Forlì (Suburban/medium-size city context)

4.1 General description of the site (geographical, urban and infrastructural context)

Via Ravegnana is a primary radial road that connects the city of Forlì with the routes leading eastward toward Ravenna and the Adriatic coast. It serves as one of the main urban–regional corridors of Forlì, serving both local accessibility and through traffic. The road accommodates mixed uses, providing access to residential areas, small industries, commercial premises, and services, while also functioning as a strategic link between the urban centre of Forlì and the surrounding plain.

Forlì is a medium-sized city in Emilia–Romagna (approximately 118,000 inhabitants), located along the Via Emilia corridor and integrated into the regional transport network connecting Bologna, Cesena, and Ravenna. Via Ravegnana thus plays a crucial role in the east–west mobility axis, supporting daily commuting flows and local logistics movements. The surrounding environment transitions from urban and mixed-use districts near the city centre to industrial and semi-rural areas on the outskirts, making this corridor an ideal site to study pavement performance, acoustic behaviour, and surface durability under diverse traffic and environmental conditions.


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GreenVet - Apa-ct S.r.l.
Hotel San Giorgio, Sure Hotel Collection
Globus City S.r.l
Parco dell'Antica Pieve
Via Leo Gramellini
Via F.lli Zanfini
Bar Pasticceria Paradiso
Via Sacco Nicola
Ferri Showroom Forlì
Via Ravegnana
Via G. Bulgarelli
Via Maestri del Lavoro
Via Pellegrino Artusi
SS67
Cisalfa Sport
dm Italia

Figure 2: Forlì-Via Ravegnana project section

4.2 Road and infrastructure characteristics (geometry, surface, age, maintenance)

Via Ravegnana serves as an urban–regional connector with a mixed cross-section and variable lane configuration (1–2 lanes per direction). The pavement consists of a bituminous asphalt wearing course over binder and base layers, with a structural history spanning several decades. Recent maintenance activities include patching, minor resurfacing, and drainage improvement works, though surface heterogeneity remains due to prior interventions. Ancillary infrastructure comprises sidewalks, driveways, small workshops, service stations, lighting, and safety barriers, making the corridor representative of mixed-use urban environments. Traffic includes a combination of passenger vehicles, local commercial transport, and occasional heavy vehicles, with peak congestion at intersections and roundabouts, providing an ideal environment for experimental evaluation of low-noise, high-durability pavement solutions.

4.3 Age and historical background

Via Ravegnana is a historic radial road connecting the city of Forlì to routes toward Ravenna and the surrounding plain. The road was progressively urbanized in the 20th century as the city expanded eastward, initially serving as a local access route to residential zones, workshops, and small commercial premises. Over time, it evolved into a primary urban–regional connector, accommodating through traffic as well as local commuting. The surrounding environment reflects a mixture of mid-century residential developments, small industrial plots, and service facilities, creating a corridor that blends historical urban fabric with contemporary infrastructure.

4.4 Geometry and Cross-Section

The corridor extends over approximately 4–5 km with one to two lanes per direction, depending on the segment and proximity to dense urban areas. The road alignment is predominantly straight, with roundabouts, signalized intersections, and lateral connections to local streets. Sidewalks are present in built-up segments, with variable width (1–2 m) and occasional cycle lanes. Shoulders are narrow or absent in more urban stretches. Pavement slopes and minor longitudinal gradients are consistent with the flat topography of the Romagna plain, while intersections and access points create localized acceleration/deceleration zones.

4.5 Signage and safety elements

Via Ravegnana features standard municipal road signage, including speed limits, intersection warnings, pedestrian crossings, and roundabout markings. Safety elements include guardrails near industrial or embanked sections, pedestrian refuges at crossings, and pole-mounted LED street lighting in urbanized areas. Some signage shows moderate wear or partial obstruction by vegetation, typical of a road serving mixed residential, commercial, and industrial uses. Traffic-calming elements, such as roundabouts, contribute to speed regulation and influence dynamic vehicle loads.

4.6 Overall conditions

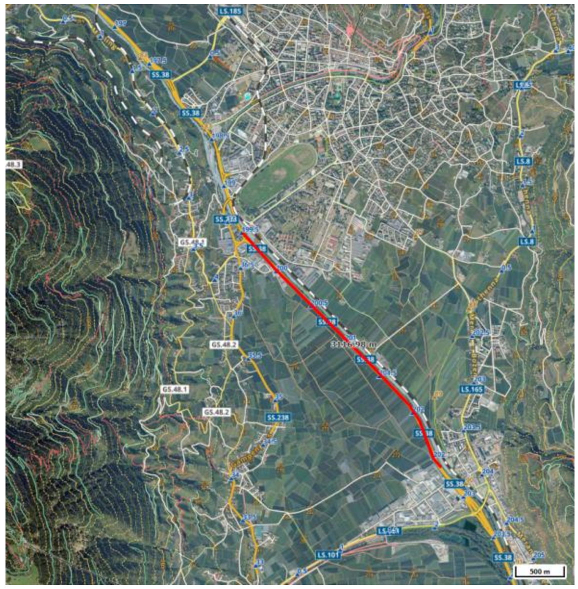
- Potentially exposed groups: residents living in buildings adjacent to the road (especially ground floors and façades facing the street), schools/childcare if present on short side streets, and any elderly care facilities in the immediate urban sector.

5 Pilot Case 3 – Bolzano Province (Mountain/extra-urban context)

5.1 General description of the site n.1 (Bolzano–Merano Expressway SS 38)

The MEBO expressway, a main interurban road 37.1 km long, was opened to traffic on August 2, 1997, and runs along the Adige Valley up to Bolzano.

The road section that will host the pilot project is located between km 199.500 and 202.100 on the southbound carriageway of the Bolzano–Merano expressway (MEBO), adjacent to the town of Marlengo. Marlengo is a municipality of just under 3,000 inhabitants in the Burgraviato district, between the cities of Merano and Bolzano. It lies at an elevation of 363 m a.s.l. To the east, it is bordered by the Adige River, and the road section concerned runs along its right bank.


500 m

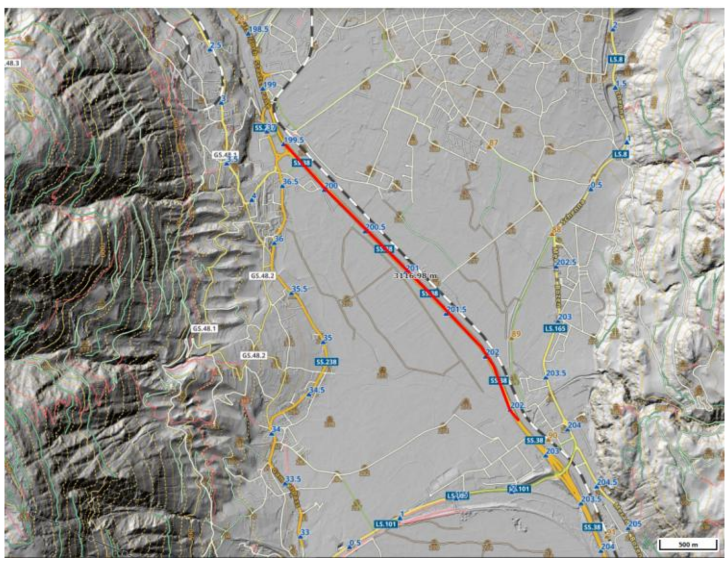

500 m

Figure 3: Bolzano–Merano Expressway SS 38 project section

5.2 Road and infrastructure characteristics (geometry, surface, age, maintenance)

This southbound MEBO section, approximately 2.6 km long, features a two-lane dual-carriageway configuration with paved shoulders and a separation median. The bituminous surface consists of a dense-graded asphalt wearing course over a polymer-modified binder, laid on a continuously reinforced base layer. Routine maintenance is managed by the Servizio Strade della Provincia Autonoma di Bolzano, including annual surface inspections, winter operations, and periodic resurfacing every 10–12 years. The homogeneous geometry, moderate traffic speed, and stable subgrade make this section particularly suitable for controlled pilot testing of innovative road surfacing materials.

5.3 Age and historical background

The Bolzano–Merano expressway (known as MEBO, from Merano–Bolzano) was constructed in the late 1980s and early 1990s to provide a high-capacity link between the Adige Valley's two main urban centres. The infrastructure, operated under provincial management by the Autonomous Province of Bolzano/Bozen, has undergone several rehabilitation and upgrading campaigns over the past three decades. The southbound section between km 199.500 and 202.100, located near Terlano/Terlan, serves as part of the original dual-carriageway layout, designed to accommodate medium-to-high traffic volumes with modern geometric standards and safety barriers. Over time, the MEBO has become a crucial corridor for daily commuters and freight transport, integrating with the A22 Brenner motorway and the regional road network.

5.4 Geometry and cross-section

The selected section lies on a straight and level alignment along the Adige valley floor, with a carriageway width of approximately 12 m (two traffic lanes plus paved shoulder). The cross-section includes a bituminous pavement, asphalt shoulders (1.0 m), and steel safety barriers separating the opposing carriageways. The longitudinal gradient is below 1 %, and the horizontal curvature is negligible, providing a geometrically uniform stretch suitable for consistent surface testing. Drainage is ensured by linear surface channels and gully pots connected to the expressway's storm-water collection system. The verge area is grassed and regularly maintained, providing sufficient space for instrumentation and maintenance operations without traffic disruption.

5.5 Signage and safety elements

The MEBO corridor complies with national motorway standards (CNR/ANAS) for signage and safety. Vertical signage is clear and regularly spaced, including speed limits (110 km/h for cars) and directional panels for the Terlano and Bolzano Sud interchanges. Horizontal markings are in retro-reflective thermoplastic paint, renewed periodically. Continuous guardrails (steel type H2) and central concrete barriers are present along the entire segment. Emergency telephones and lighting systems are installed near junctions, while the open rural environment of this stretch does not require continuous illumination. Safety devices are well maintained and compliant with current road-safety directives.

5.6 Overall condition

The pavement condition is very good, following resurfacing and structural reinforcement works performed in 2021–2022 as part of a province-wide maintenance programme. The surface texture is homogeneous, with no significant rutting or cracking, and presents ideal baseline characteristics for the installation of experimental low-noise or high-durability asphalt layers. Drainage performance and skid resistance are adequate, while the roadside environment is free from obstructions. Overall, the site offers a controlled, high-quality infrastructure with consistent traffic and environmental conditions, well suited for long-term monitoring of material and acoustic performance.

5.7 General description of the site n.2 (Bolzano–SS12)

The road section designated for testing is located between km 408.200 and 410.800 (likely between km 408.500 and 409.000) and crosses the village of Laghetti, a hamlet of Egna, with 1,400 inhabitants at an elevation of 213 m a.s.l. The speed limit between km 408.200 and 409.800 is 50 km/h, and between km 409.800 and 410.800 it is 60 km/h. The Average Daily Traffic (ADT) in Laghetti is approximately 10,000 vehicles, of which 9.0% are heavy vehicles (estimated figures based on interpolated data from the Salorno and Ora traffic monitoring stations).

Currently, the wearing course of the section consists of an AR 12 type bituminous mix with rubber powder, laid in 2018. It is now severely deteriorated, showing cracking, raveling, and in some areas, potholes. The wearing course has reached the end of its service life and needs replacement. It is included in the maintenance program of the Bolzano Bassa Atesina Roads Service.

The number of people expected to benefit from the intervention is 1,400.

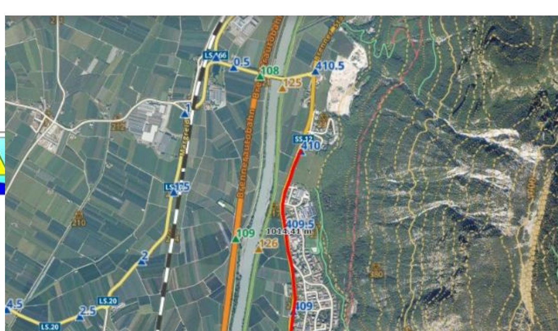


Figure 4: SS 12 project section

5.8 Road and infrastructure characteristics

The state road 12 "dell'Abetone e del Brennero" is a national road connecting Pisa to the Austrian border at the Brenner Pass. The current route was built between the 19th and 20th centuries. The first completed section of the road, between Trento and Bolzano, was already in use in 1860; additional segments were gradually constructed until 1956, when the entire route was completed.

The speed limit is set at 110 km/h. The Average Daily Traffic (ADT) in Marlengo is 32,619 vehicles, of which 4.5% are heavy vehicles.

Currently, the wearing course of the section consists of an AR 12 type bituminous mix, laid in 2016 and now severely deteriorated, showing branched cracking and potholes. The section is included in the maintenance program of the Burgraviato Roads Service.

The number of people expected to benefit from the intervention is estimated at around 2,500, as the settlement is located on a slope orthogonal to the road, causing noise propagation to cover most of the residential area.

5.9 Age and historical background

State Road 12 (SS 12 dell'Abetone e del Brennero) is one of Italy's oldest national routes, established in the 1920s as part of the national road network connecting Central and Northern Italy via the Apennine and Alpine passes. The section between km 408.200 and 410.800, located near Laives/Leifers (Bolzano Province), follows the historical alignment of the Brenner corridor and serves as a complementary route to the MEBO expressway. Over the decades, the road has been progressively widened and improved to meet modern safety and capacity standards, while maintaining its original longitudinal profile within the Adige Valley floodplain. Management has since transitioned to ANAS S.p.A., which oversees its maintenance and upgrading programmes.

5.10 Geometry and cross-section

The segment develops over a length of 2.6 km, with a carriageway width of 7.5–8.0 m. It comprises two traffic lanes (3.25–3.50 m each) and narrow shoulders or roadside strips. The alignment is predominantly straight with slight curvature near industrial access points, and a nearly level longitudinal profile (< 1 %). The surrounding environment is semi-urban and industrial, with adjacent service areas, warehouses, and agricultural plots. Side drainage is achieved through shallow ditches and gully pots; pedestrian paths are discontinuous and limited to built-up stretches. The geometric configuration is suitable for instrumented monitoring with minimal interference from complex junctions or sharp curves.

5.11 Signage and safety elements

The road features standard ANAS signage, including regulatory and warning panels at major intersections and pedestrian crossings within built-up zones. Horizontal markings (edge lines, centreline) are visible but show partial fading in some sections. Guardrails and curbstones are installed along elevated or constrained edges, while reflectors and delineators are used throughout rural stretches. Lighting is present only near access roads and junctions. Speed limits range between 50 and 70 km/h, depending on the surrounding land use. Safety levels are considered adequate for a regional road of this class, though periodic renewal of markings and localised barrier replacement are ongoing.

5.12 Overall condition

The pavement displays a medium to good structural condition, with surface layers renewed in 2019 and 2021 as part of the ANAS maintenance programme. The asphalt exhibits minor longitudinal cracking and some raveling along wheelpaths, mainly due to ageing and heavy-vehicle traffic. Drainage operates effectively, and skid resistance remains within regulatory thresholds. Given its steady traffic load and partly heterogeneous surface conditions, this segment serves as an ideal test site for evaluating new asphalt mixtures with improved acoustic absorption, rutting resistance, and durability under mixed climatic and operational stress.

In the following table some information about the pilots are summarised.

Category	Data to collect	Firenze	Forlì	Bolzano - SS38 (MeBo)	Bolzano SS12
General Information	Road section	Via del Gelsomino	Via Ravegnana from civic number 506 to 538	From km 199.500 to km 202.100 on the southbound lane	From km 408.200 to km 410.800
General Information	Coordinates	Starting point: 43.750351, 11.236689; Ending point: 43.751824, 11.243819	Starting point:44.247607, 12.081404; Ending point: 44.249732, 12.085048	Starting point: 46.634129, 11.172181; Ending point: 46.656268, 11.146652	Starting point: 46.265730, 11.235120; Ending point: 46.282927, 11.239858
General Information	Length	About 600 m	About 400 m	About 2,5 km	About 2,5 km
General Information	Administrative responsibility	Municipality of Florence	Municipality of Forlì	Province of Bolzano	Province of Bolzano
Road and Infrastructure Characteristics	Road typology	Local access road	Road type DE: Inter-district roads	Highway	National road
Road and Infrastructure Characteristics	Number of lanes / carriageways	2	2	4	2
Road and Infrastructure Characteristics	Geometry	9,75 m wide	9,75 m wide	12 m wide	6 m wide
Road and Infrastructure Characteristics	Existing surface type	Traditional worn asphalt	Traditional worn asphalt	AR 12 asphalt concrete, installed in 2016	AR 12 rubberized asphalt concrete, laid in 2018
Road and Infrastructure Characteristics	Current condition	Some minor depressions/presence of some dips	Some minor depressions/presence of some dips	Heavily deteriorated with branched cracking and potholes	Heavily deteriorated, exhibiting cracking, raveling, and potholes in some areas. The wear layer has reached the end of its useful life and must be replaced.

Traffic Data	Average Daily Traffic (ADT)	10.224	13.270	32.619	10.000
Traffic Data	Traffic composition - Light vehicles (%)	75,5%	92,3%		
Traffic Data	Traffic composition - Heavy vehicles/trucks (%)	6,4%	3,6%	4,50%	9%
Traffic Data	Traffic composition - Medium vehicles (%)	3,0%	2,0%		
Traffic Data	Traffic composition - Motorcycles (%)	16,1%	2,1%		
Traffic Data	Peak hour traffic (if available)				
Traffic Data	Speed regime (posted limit)	50 km/h	50 km/h	110 km/h	60 km/h
Traffic Data	Measured average speed				
Environmental and Urban Context	Surrounding land use	Residential / Commercial	Residential / Industrial / Commercial		
Environmental and Urban Context	Population exposed within 50–100 m	931	114	2.500	1.400
Environmental and Urban Context	Sensitive receivers	No	No		
Environmental and Urban Context	Green areas/barriers	No / No	No / No	Yes/	Yes/
Exposure to Road Activity	Noise baseline - Daytime dB(A)	49,9	72		
Exposure to	Noise baseline -	39,1	48		

Road Activity	Nighttime dB(A)				
Exposure to Road Activity	Noise source / measurement method	Road / CNOSSOS-EU: 2021/2015	Road / CNOSSOS-EU: 2021/2015		
Exposure to Road Activity	Air quality baseline *(NOx, PM10, PM2.5)		ARPAE - No NO2, PM2.5 exceedings, there have been 3 exceedances of the daily value for PM10 in January 2025	Agenzia provinciale per l'ambiente e la tutela del clima: PM10, PM2.5, NO2 under threshold	Agenzia provinciale per l'ambiente e la tutela del clima: PM10, PM2.5, NO2 under threshold
Climatic and Geographic Conditions	Altitude	90 m a.s.l.	16 m a.s.l.	363 m a.s.l.	213 m a.s.l.
Climatic and Geographic Conditions	Climate classification	Humid temperate climate	Warm temperate climate, consistently humid	Semi-continental climate	Semi-continental climate
Climatic and Geographic Conditions	Average annual temperature (°C) - 2024	17°	14.4°	14.1°	14.1°
Climatic and Geographic Conditions	Average annual precipitation (mm) - 2024	928	1208,2		
Climatic and Geographic Conditions	Presence of snow/ice and winter maintenance practices	No	No		

* https://www.arpat.toscana.it/temi-ambientali/aria/qualita-aria/rete_monitoraggio/scheda_stazione/FI-MOSSE

6 Conclusions and Next Steps

6.1 Summary of findings

The analyses conducted within Deliverable D2.4 have provided a detailed characterization of the three pilot sites identified within the LIFE OPTIMUS project—Florence, Forlì, and the Province of Bolzano—representing a comprehensive spectrum of urban, suburban, and extra-urban contexts.

The collected data confirm the suitability of the selected pilot sites as representative environments for the demonstration and validation of optimized low-noise asphalt technologies under real operating conditions. Each site exhibits distinctive features in terms of traffic typology, environmental exposure, and infrastructural configuration:

- Florence (urban context): high population density and direct exposure of residents, with predominantly light vehicular traffic and a strong influence of stop-and-go dynamics typical of low-speed regimes.
- Forlì (suburban context): intermediate-speed road with mixed traffic composition, combining residential, industrial, and peri-urban functions, providing a transitional case between dense urban and rural networks.
- Bolzano Province (extra-urban/mountain context): high-speed corridors with a significant proportion of heavy goods vehicles, marked climatic variability, and sensitive settlement exposure, particularly in the Marlengo and Laghetti areas.

The comparative analysis of infrastructural, traffic, and environmental parameters has demonstrated that the three pilots collectively encompass the main conditions influencing road noise emissions across Europe. The baseline characterization thus establishes a robust foundation for the design, implementation, and subsequent evaluation of innovative asphalt mixtures within the LIFE OPTIMUS framework.

The data sets produced—covering geometric parameters, traffic intensity and composition, acoustic exposure, air quality indicators, and climatic conditions—constitute a coherent reference for subsequent phases involving Life Cycle Assessment (LCA), Life Cycle Costing (LCC), and Multi-Criteria Decision Analysis (MCDA).

6.2 Relevance for project subsequent phases

The outcomes of this deliverable directly support the technical and methodological development of the LIFE OPTIMUS project, providing the reference baseline for pilot implementation, monitoring, and performance assessment. Specifically:

Information gathered will inform the selection, optimization, and design of asphalt mixtures with enhanced acoustic performance and environmental sustainability.

- The installation and monitoring phases of the pilot pavements will rely on the data reported herein to perform consistent pre- and post-intervention comparisons, enabling quantification of noise reduction, durability, and maintenance benefits.

- The pilots will serve as full-scale demonstrators for evaluating real-world effectiveness of low-noise pavement technologies, assessing both technical performance and social benefits in terms of residents' exposure reduction.
- The results will contribute to the formulation of evidence-based recommendations and guidelines aimed at ensuring replicability and scalability of optimized pavement solutions at the European level, supporting policy development and integration within sustainable mobility strategies.

In summary, Deliverable D2.4 establishes the methodological and analytical foundation required for the subsequent project activities. It enables the LIFE OPTIMUS consortium to proceed towards the experimental implementation of optimized low-noise asphalt pavements, the monitoring of their acoustic and structural performance, and the assessment of their overall environmental and socio-economic impact in line with EU environmental objectives and noise mitigation policies.